Air Force Scientific Advisory Board

Airborne Tactical Laser (ATL) Feasibility for Gunship Operations

2008 AF SAB Study
Presented at 34th Air Armament Symposium
8 October 2008

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Promise of Tactical Laser on a Gunship

Key attributes:

- Precision lethality
- Track and hit moving targets
- "Danger-close" of meters
- Minimal collateral damage
- Clandestine and invisible engagements
- Deep, onboard re-chargeable magazine*
- Variable effects – disrupt to destroy
- Reduce platform vulnerability
- Fewer crewmembers needed

* Electric lasers only, chemical lasers require chemical replenishment

Terms of Reference -Charter-

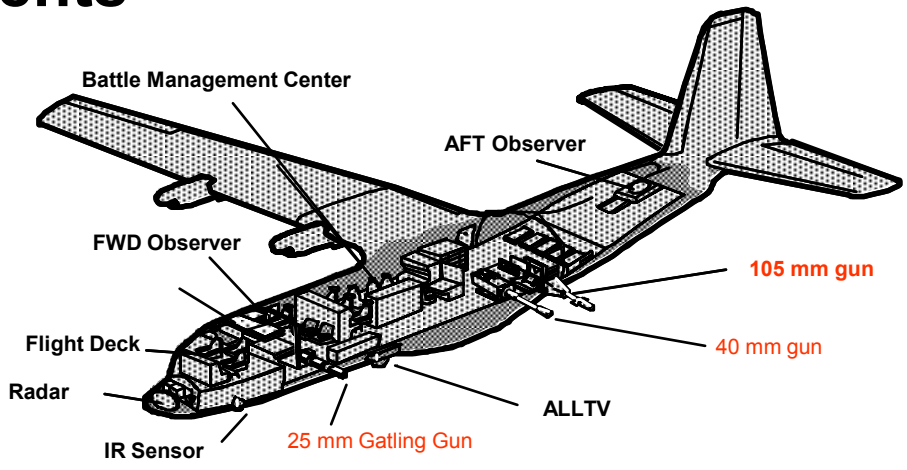
- Assess current state of airborne tactical laser technologies
  - Consider both chemical and electric/solid state lasers
  - Identify platform integration issues (on C-130, C-27, C-17)
- Examine gunship operations and tactics, techniques and procedures
  - Identify missions, operational requirements, logistics or sustainment issues which might limit laser weapons employment
- Assess tactical laser effectiveness against offensive and defensive gunship targets
  - Identify potential effects
  - Assess vulnerability and countermeasures
- Recommend technology options for near, mid, and far-term

Outline

- Gunship mission
- System considerations
- Advanced Tactical Laser (ATL) ACTD
- Recommendations

Current Gunship Mission

- **Tactics**
  - Night time and day time permissive ops due to platform vulnerability
  - Close-in pylon turn
- **Principal Gunship requirements**
  - Situation awareness
  - Lethality
  - Persistence
  - Survivability



Effectiveness and Tactical Target Lethality

Laser Weapons More Effective (Lower Collateral Effects)

Kinetic Weapons More Effective (Larger Explosive Effects)

Soft/Small/Fast **Moving/tactical** **Hardened or Large Area**

Laser & kinetic weapons could play complementary roles
A Gunship with both laser and kinetic weapons can execute more missions

Outline

- Gunship mission
- **System considerations**
  - High energy laser choices
  - Beam control and atmospheric propagation
  - Aircraft integration & options
- Advanced Tactical Laser (ATL) ACTD
- Recommendations

System Considerations

Weapon lethality: ~2 kW/cm^2 at 7 km, dwell time 1/2 s to <10s

System Attribute

- Laser power
- Laser efficiency
- Thermal management
- Duty cycle
- Aperture
- Beam quality
- Jitter
- Atmospheric effects
- Standoff

Weight and "wall plug" power requirements

Target prosecution rate

Spot size on target

Survivability

High Energy Lasers

Attribute	COIL (1.31 um)	Bulk SSL (1.06 um)	Fiber SSL (1.07 um)
Propagation Effects			
Ocular Hazard			
Rechargeable Magazine			
Technical Maturity			

Solid State Laser provides a technically maturing option with operationally relevant magazine depth, good beam propagation, and decreased danger close distances

Beam Control for Laser Gunship

Disturbance	Severity
Jitter (Platform motion)	Severe
Aero-optics Turbulence	Benign in forward region
Atmospheric Turbulence	Benign
Thermal Blooming*	Significant (COIL) Benign (SSL)

*Distortion caused by laser heating of the atmosphere (water vapor)

Principal challenges: Maintenance of aimpoint and rejection of platform-induced jitter
Payoff: Reduces laser power, and lower system weight

Trade Offs between Laser Power, Aperture and Jitter

Bigger Optics or More Laser Power?

Larger Laser, *Smaller* Aperture	*Smaller* Laser, *Larger* Aperture
▪ Simpler beam director integration ▪ Reduced requirements on beam quality and jitter ▪ Stressing thermal/power integration	▪ Simpler laser integration ▪ More stringent requirements on beam quality and jitter ▪ Enhanced ISR capability

- Laser requirements can be considerably reduced by increasing aperture size and reducing platform jitter
- Same lethality is achievable with variety of power-aperture combinations with system implementation (e.g., weight) implications
- High fidelity system models are needed to guide laser weapon system development

System Considerations

- **Weapon lethality: ~2 kW/cm^2 dwell time 1/2s to < 10s**
- **Mission characteristics:**
  - 7 km slant range, 50 s continuous run time
  - 10% duty cycle

System Attribute	Nominal System Design
Laser Power	100 kW
Efficiency	14%
Thermal Management	615 kW Peak load input 31 MJ storage 310 kW dissipation
Duty Cycle	10%, 50s continuous run time
Beam Quality	2
Jitter	2 urad
Atmospheric Effects	Compensation not needed
Aperture	50 cm
Standoff	7 km slant range

Platform Integration

AC-130 and AC-27 gunships

- **Key challenge to A/C Integration:**
  - Available weight and volume
  - Electric power
  - Thermal management
  - Platform vibration isolation
- **Onboard capabilities vary across platforms**
  - Available A/C engine power
  - Use A/C fuel as thermal sink
  - Ram air cooling (non Low-Observable)

Finding: Laser Augmented Gunship is Potentially Feasible for AC-130

Add laser system: SSL 100 kW, 50 cm aperture, 50 s run time, 10% duty cycle
Retain: 105 mm gun
Remove: 25 and 40 mm guns

Payload removed	Laser weapon system payload added
■ 25mm & 40mm guns, ammo, rack ■ Fewer crew members (2) ■ ALLTV ■ Rest station ■ Weight equivalent of drag count	■ Laser device ■ Beam Director/Optics ■ Electric Power System ■ Thermal Management System ■ C3 for laser

Finding: Laser Augmented Gunship is Potentially Feasible for AC-27

Add Laser system: SSL 75 kW, 50 cm aperture, 50 s run time, 10% duty cycle
Add other weaponry: precision guided munition (SOPGM) for complementary weaponry effects

Laser weapon system payload added

- **Laser device**
- **Beam Director/Optics**
- **Electric Power System**
- **Thermal Management System**
- **C3 for laser**
- **Mission Systems (no 30 mm gun)**
- **SOPGMs (50)**

Gunship Operational Options

- AC-130 with an integrated laser weapon system and retaining 105mm gun
  - Expanded mission with combined HEL and KE
- Flight of two aircraft, for example:
  - AC-27 with laser weapon, AC-130 with guns only
    - AC-27 operates as an adjunct to AC-130
    - Battle management resides in the AC-130
    - Two-way data link with streaming video
  - Two AC-27s (one with guns, one with HEL)

Outline

- Gunship mission
- System considerations
- **Advanced Tactical Laser (ATL) ACTD**
- Recommendations

Advanced Tactical Laser (ATL) ACTD

NC-130

Objective

Demonstrate Military Utility Assessment of Modular HEL Weapon for Ultra-Precision Strike Missions

Key Attributes

- Fills the entire C-130 Cargo Bay
- 50 cm optics in a 130 cm retractable turret
- Sealed Exhaust COIL

ATL ACTD Status

- Low power ground and flight tests completed
- High power laser installed on the aircraft and activated (on the ground)
- High power flight test not yet conducted
- ACTD to end in September 2008
  - Followed immediately by an EUE

As an integrated platform, could provide unique test and evaluation opportunity

Outline

- Gunship mission
- System considerations
- Advanced Tactical Laser (ATL) ACTD
- **Recommendations**

Recommendation 1: Near Term Technology Development

Start with system analysis for combined laser and kinetic Gunship, ensure technology developments are consistent with system requirements

- **Initiate a comprehensive system engineering program to integrate laser weapon system on a Gunship**
- **Complete programs to mature SSL**
- **Aggressively pursue beam control system improvements including better jitter control and lightweighting**
- **Lightweight and improve electric power and thermal management technologies**

Recommendation 2: Mid and Far Term Technology Development

- Incorporate future laser weapon system technologies for a Gunship (AC-130 or AC-27) into Air Force laser weapon roadmap:
  - Develop higher power, higher efficiency fiber SSL
  - Develop higher power, higher efficiency bulk SSL
  - Enhance beam control technologies (jitter below diffraction limit)
  - Reduce the total system weight
- Focus funds on developing a fieldable laser system
  - Build a laser weapon system which meets size, weight, power, laser efficiency, beam quality and jitter requirements
  - Design program based on goal of militarily useful system

Fund platform modification only after laser system is well demonstrated

Recommendation 3: Extended User Evaluation (EUE) Using ATL

Purpose of EUE: Assess potential military utility

- **Develop a detailed, comprehensive EUE Plan**
- **Explore a range of scenarios using integrated airborne testbed**
  - **Repeat and expand target sets beyond the 2 DRMs**
  - **Include diagnostics of beam at target**
  - **Validate detailed M&S for alternative scenarios**
- **Restrict upgrades of the ACTD configuration to beam control**
  - **Measure platform jitter impacts on system performance**
  - **Retain existing COIL as is for EUE**
- **Emphasize potential user test and evaluation**
  - **Develop CONOPS**
  - **Conduct ground tests to enhance current lethality database**

Summary

- Laser development for Gunship applications should focus on solid-state laser (SSL) solutions
  - SSL more promising for gunship operations
    - Less absorption in the lower atmosphere
    - Larger magazine
    - Less complex logistics requirements
- Suggested way ahead – Develop future gunship with combined SSL and kinetic capabilities
  - Demonstration of laser system as first step before platform modification

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